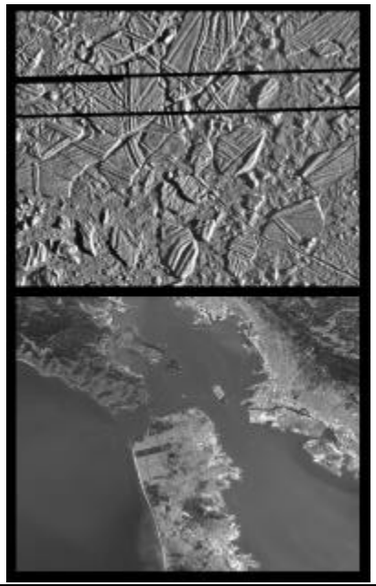
Europa Orbiter Mission



In the top frame is one of the most recent images of the surface of Europa sent back by the spacecraft *Galileo,* depicting a fascinating topography of hills, ridges, upwellings, and ice floes suggesting motion enabled by ice-crusted water or soft ice close to the surface at the time of disruption. The lower frame shows the San Francisco Bay area of California. Both images show areas of equal size, 34 by 42 kilometers (21 by 26 miles), and similar resolution.

Europa is one of Jupiter's four largest moons. Recent images have been relayed back by the *Galileo* spacecraft, which is exploring Jupiter and its moons. Europa has a surface of water ice. Some scientists suggest that an ocean may exist beneath this icy surface, perhaps warmed by Europa's inner core.

The main purpose of the *Europa Orbiter* mission is to determine if there is a liquid ocean beneath the icy surface and if so, how thick the ice is.

The cover of this brochure depicts a possible spacecraft in orbit around Europa!

OUTER PLANETS/SOLAR PROBE PROJECT

Europa Orbiter is part of the ***Outer Planets/Solar Probe Project,*** a multimission approach to Solar System exploration. Scientists and engineers are designing small, inexpensive, *smart* spacecraft, science instruments, avionics, and ground systems for a variety of Solar System destinations.

MISSION SCIENCE QUESTIONS

- Does Europa have oceans?
- If so, how extensive and how deep are they?
- What can we tell from the surface?
- What is the ice crust really like?
- What is the energy source for the ocean?

MISSION HIGHLIGHTS

- Flight time to Jupiter of 3-4 years
- Approach to Jupiter with Io flyby
- Jupiter Orbit Insertion (JOI), getting into orbit around Jupiter
- "Galilean" satellite tour, gradually slowing down, to reach Europa in 18-24 months
- Europa Orbit Insertion (EOI) maneuver to circularize orbit
- Orbit parameters : initial circular orbit altitude 100-500 kilometers (60-300 miles), inclination of 60-90º, nominal science mission of 30 days

POSSIBLE SCIENCE INVESTIGATIONS

- Radar Sounder
- Measurement of tides from precise tracking of the spacecraft along with Laser Altimeter readings (~1 meter or 3.28 feet accuracy)
- Wide Angle Imager (100 meters or 328 feet/line pair)
- Narrow Angle Imager (10 meters or 32.8 feet/line pair)
- Very High Resolution Camera (1 meter or 3.28 feet/line pair)
- Infrared (IR) Spectrometer (256 channels/1 kilometer or 0.6 miles pixel)
- Thermal Imager

EDUCATIONAL OUTREACH

The ***Outer Planets/Solar Probe Project*** has made significant strides toward making space exploration more accessible to everyone. Educational outreach efforts have directly involved over 100 college students from universities all over the country in hands-on roles working on designing the mission. Many hundreds of teachers have attended teacher enhancement workshops sponsored by the Project. Thousands of K-12 students have participated in the ***Outer Planets/Solar Probe Project*** educational programs.

The ***Outer Planets/Solar Probe Project*** Educational Outreach Program has developed a series of Teacher's Guides containing innovative exercises to enhance educators' efforts to teach space science to students of all ages.

These research-based teaching strategies encourage both *critical thinking* and *kinesthetic* approaches, engaging the body and the mind in ways that allow students to *live* the learning experience.

In one activity, students become living components of a model of *Europa* in order to understand how scientists infer that there might be an ocean beneath its icy surface. These *minds-on activities* develop an intuitive grasp of space science concepts and encourage an attitude of life-long learning.

For further Europa Orbiter Information

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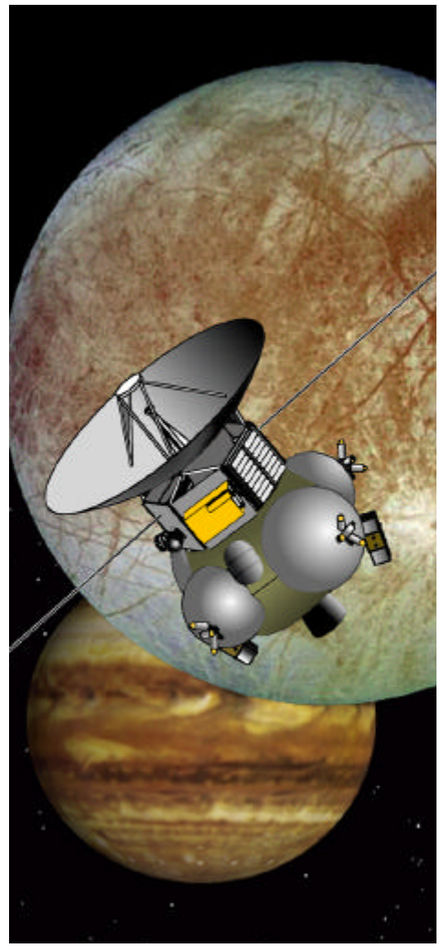
Europa Orbiter: Oceans Under Ice?

OUTER PLANETS/SOLAR PROBE PROJECT

Ice and Fire MISSIONS



National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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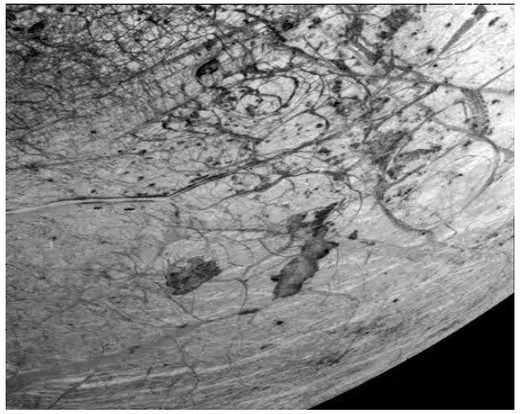
The Jet Propulsion Laboratory (JPL), California Institute of Technology, manages the Outer Planets/Solar Probe Project for the National Aeronautics and Space Administration (NASA).

EUROPA STIRS THE IMAGINATION: ICY SURFACE, WISPY ATMOSPHERE, SALT SLICKS, YOUNG CRATERS—OCEANS BENEATH THE ICE?!

Galileo first saw Jupiter's moon Europa through his telescope back in 1610. Back in the late 1970's, Earth-based telescopic spectra showed that it was covered with ice. In 1979, Voyager sent back the first views of surface features showing Europa's smooth icy surface, crisscrossed by fracture-like features hundreds of miles long. The *Galileo* spacecraft has been sending back spectacular close-up images and other data that have begun to give us a detailed look at a surface that resembles ice-covered areas on Earth. The *Galileo Europa Mission* is swinging by repeatedly to obtain even more and higher resolution images. What's next? The *Europa Orbiter*, an Ice and Fire mission of the Outer Planets/Solar Probe Project, is scheduled for launch in 2003 to attempt to discover whether Europa has a liquid-water ocean beneath its surface. What does Europa have to teach us? Why should we explore Europa?



Europa, as viewed by the *Galileo* spacecraft.

QUESTION: How do oceans form on planets?

About 4 1/2 billion years ago, a cloud of gas and stellar dust in our region of the Milky Way began to swirl and form a hot and active star. As other portions of the whirling dust cooled, planetary bodies condensed and collided. Rocky and icy debris cluttered the outer regions beyond.

—By exploring Europa, we are looking for further evidence of this process!

Outer Planets/Solar Probe Project, "The Ice and Fire Missions"

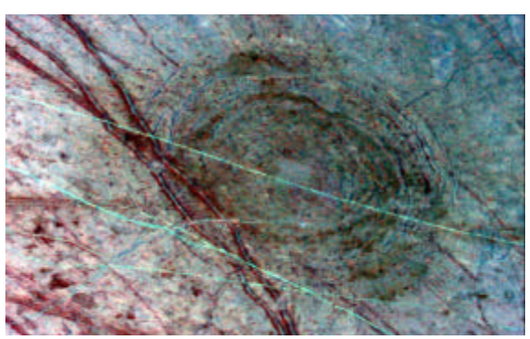
are preparing for NASA's effort to find answers to these kinds of questions.

We want to hear from you! Please send us your thoughts and comments.

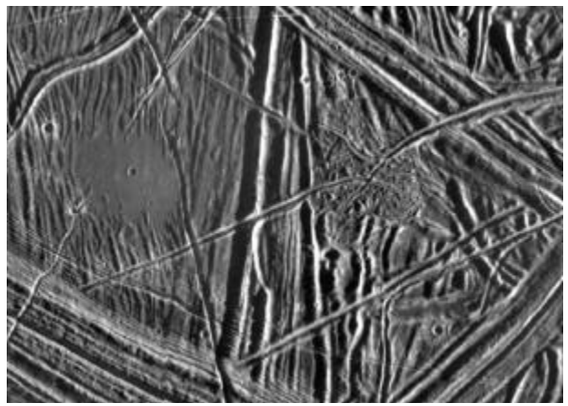
QUESTION: Where in the Solar System do we find water? Is water plentiful or scarce?

In the inner Solar System, aside from Earth, we find signs of small amounts of water on Mars, even on the Moon—but it is in the frigid realms of the outer Solar System where water reigns supreme, with entire worlds being formed in part by water ice. The icy shell covering Europa's surface may hold the largest extraterrestrial volume of water in the Solar System! How did the water get there? Water is one of the main constituents of the material that formed the bodies of the outer Solar System, including comets. The raining in of icy comets from outer planetary regions may have been and still is an important source of water throughout the Solar System!

—By exploring Europa, we may find clues to help us understand the role of water in the Solar System!



Ancient impact crater on the surface of Europa.



Europa's icy surface features.

QUESTION: What is the importance of an ocean? Does an ocean mean life? Can we leap to such conclusions? And what if we do find life there?

Our concepts about the environmental conditions necessary for life are changing with each new discovery. Recent discoveries of life deep in the crust of the Earth have led scientists to conclude that there may be more biomass beneath Earth than on its surface! Deep thermal vents on Earth's ocean-floor have been found to be teeming with life! Perhaps there is life beneath the icy surface of Europa.

—By exploring Europa looking for signs of an extraterrestrial ocean, we may discover new ways to think about life itself!

QUESTION: Why do we care whether Europa has liquid water?

All the tantalizing possibilities of finding water on Europa have resulted in the need to make hard choices. As new discoveries stir interest, we engage in the process of deciding on an exploration strategy, how to get there, and what to do there.

—By developing advanced technologies while being mindful of our limitations, we are challenging ourselves to find new ways of achieving our objectives, that are both scientifically sound and cost effective!

QUESTION: With all that is going on in the world, why should we explore Europa?

We explore space to learn more about Earth and to benefit humanity as a whole. The questions we ask and the answers we get have the potential to transform our lives. We must decide on a specific set of questions to be answered by a space mission. The science and technology community must work together, in concert with society as a whole, to develop the right questions that can be asked remotely, in the form of science instruments taking measurements aboard spacecraft—acting as an extension of our senses.

—By participating in the ongoing public debate about space, we help define the questions!